REMARKS

The Final Office Action mailed January 14, 2003, has been received and reviewed. Claims 1 through 4, and 6 through 15 are currently pending in the application. Claims 1 through 4, and 6 through 15 stand rejected. Applicants respectfully request reconsideration of the application.

35 U.S.C. § 103(a) Obviousness Rejections

Obviousness Rejection Based on U.S. Patent No. 5.439 553 to Grant et al. in view of U.S. Patent No. 4,372,803 to Gigante and further in view of U.S. Patent No. 6.251 742 to Lilt

Claims 1 through 4, and 6 through 15 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Grant et al.(U.S. Patent No. 5,439,553) in view of Gigante (U.S. Patent No. 4,372,803) and further in view of Lin (U.S. Patent No. 6,251,742). Applicants respectfully traverse this rejection, as hereinafter set forth.

M.P.E.P. 706.020) sets forth the standard for a Section 103(a) rejection:

> To establish a *prima facie* case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or combine reference teachings. Second, there must be a reasonable expectation of success. Finally, **the prior art reference (or references when combined) must teach or suggest all the claim limitations.** The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, and not based on applicant's disclosure. In *re Vaeck,* 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991). (Emphasis added).

Grant discloses a dry (gaseous/vapor) etch wherein oxides are etched with a halide-containing species and a low molecular weight organic molecule having a high vapor pressure.

Gigante discloses a method for etch thinning silicon devices in charged coupled imagers. The disclosed devices do not include BPSG and TEOS, but instead include a p+ doped substrate. The method includes three sequential etches including a first etchant of 2 parts KOH to 2 parts 1-1_20 at 60°, a second etchant of 1 part HF to 3 parts $HN0_3$ to 10 parts acetic acid and a critical

amount of H_20_2 and water, and a third etch of 1 gm potassium permanganate. 150 ml HF and 150 ml acetic acid. (Gigante, col. 4, lines 1-38).

Lin discloses a method of manufacturing a cup-shaped capacitor. A P-type substrate 2 is provided with a thick field oxide region 4. A silicon dioxide layer 6 is formed as a gate oxide on the substrate 2. A first polysilicon layer 8 is formed over the silicon dioxide layer 6 and field oxide regions 4. Dielectric layers 20, 22 are formed thereover. An etch stop layer 24 is formed over the dielectric layers 20, 22 and another dielectric layer 26 is formed on the etch stop layer 24. A two-step etching process creates slots 30 in the dielectric layer 26 and stops at the etch stop layer 24. (Lin, FIG. 2)

By way of contrast with Grant, Gigante and Lin, independent claim 1 of the presently claimed invention recites, an etchant solution which selectively etches borophosphosilicate glass over tetraethyl orthosilicate, said etchant solution comprising an organic acid and a fluoride containing solution provided in a selected volumetric ratio relative to one another, wherein the selected volumetric ratio of the organic acid to the fluoride-containing solution is about 10:1 to about 500:1.

Applicants respectfully submit that the proposed combination of references fail to teach or suggest every element of the presently claimed invention. Applicants respectfully submit that Grant does not disclose a **selective etchant solution,** but rather a **vapor phase treatment method.** (Grant, Abstract). Further, it is submitted that the equivalence of a liquid and vapor etch for selectively etching BPSG over TEOS has not been established. To the contrary, the specification of the present invention states that there are disadvantages associated with a vapor, as opposed to a liquid, etchant. (Specification, page 3). Further, as explained more fully below, Lin fails to establish this equivalence. The Examiner also cites three other references (U.S. Patent 5,654,244 to Sakai, U.S. Patent 6,335,279 to Jung and U.S. Patent 6,077,742 to Chen) as disclosing the equivalence of vapor-phase and liquid-phase etchants. However, none of these references appears to disclose the equivalence of a liquid and vapor etch for selectively etching BPSG over TEOS as recited in the presently claimed invention.

The Grant method of etching oxides includes a gas phase mixture of a halide-containing species and low molecular weight molecule having a high vapor pressure at standard conditions.

(Grant, col. 3, lines 58-61). While Grant discloses that this method may be used with BPSG, it lacks any disclosure of whether the gas mixture may be used with both BPSG and TEOS, and does not mention any selectivity for BPSG over TEOS. Rather, Grant merely discloses that a BPSG oxide can be etched with the disclosed vapor phase treatment. (Grant, col. 1, lines 7-9; col. 7, lines 12-13).

Applicants respectfully disagree that Lin teaches the equivalence of liquid and vapor-phase etchants. (Paper No. 21, page 2). Instead, Lin merely discloses the acceptability of an etchant of either HF solution, HF vapor or BOE within the Lin invention. Further, Lin discloses the use of such etchants with an etch stop layer 24 which is contrary to the present invention. (Lin, col. 3, lines 49-64). Accordingly, applicants submit that Lin lacks any disclosure that this solution preferably etches BPSG to TEOS. Thus, applicants submit that Lin fails to teach or suggest the "equivalence between HF solutions and vapor-phase etchants for layer etching" as it fails to disclose anything regarding preferential etching. (Paper No. 21, page 2).

Further, applicants respectfully submit that Gigante also fails to correct the deficiencies of Grant. Gigante discloses a method for etch thinning silicon devices in charged coupled imagers. The method includes three sequential etches including a first etchant of 2 parts KOH to 2 parts H_2O at 60°, a second etchant of 1 part HF to 3 parts $HN0_3$ to 10 parts acetic acid and a critical amount of H202 and water, and a third etch of 1 gm potassium permanganate, 150 ml HF and 150 ml acetic acid. (Gigante, col. 4, lines 1-38). However, even assuming Gigante disclosed an etchant composition comprising on organic acid and HF in a ratio of 10:1, Gigante lacks any disclosure that such a composition would be suitable in the present invention. The etchant in Gigante is used on a disclosed device which ***does not*** include BPSG and TEOS, but instead includes a p+ doped substrate. Gigante lacks any disclosure that this solution preferably etches BPSG to TEOS. Instead, Gigante merely discloses the use of the etchant solutions to etch-thinning silicon devices with a p+ surface.

In contrast, the present invention comprises a solution for use in a wet etching process wherein a semiconductor device., which contains BPSG *and* TEOS, can be selectively etched by an etchant solution comprising an organic acid and a fluoride-containing solution provided in a selected volumetric ratio relative to one another, wherein the selected volumetric ratio of the

organic acid to the fluoride-containing solution is about 10:1 to about 500:1. An exemplary application of this invention includes a TEOS layer deposited over the semiconductor device 6 components, followed by a BPSG layer deposited over the TEOS layer. (Specification, page 3, lines 18-20.) The TEOS layer is used to prevent boron and phosphorus in the BPSG layer from contaminating the components of the semiconductor device. (Specification, page 3, lines 15-17.) The etchant solution is used to etch desired areas in the uppermost BPSG layer. Since the etchant solution is between 27-55 times more selective for BPSG than for TEOS, the solution will etch the BPSG layer but will substantially cease etching when the TEOS layer is exposed. (Specification, page 3, lines 20-22; Page 4, Table 1.)

Since Grant does not teach or suggest an etchant solution of the claimed constituency that selectively etches **BPSG** over TEOS, Grant fails to teach or suggest every element of claim 1. The Examiner further acknowledges that Grant fails to teach or suggest the claimed volumetric ratio of the organic acid and fluoride-containing solution. (Paper No. 21, page 2). However, as stated, applicants respectfully disagree with the Examiner's statement that Gigante teaches or suggests the claimed volumetric ratios would be successful in the presently claimed invention. (Id.).

Applicants respectfully disagree that "it would have been obvious to one of ordinary skill in the art at the time of the invention to modify Grant by utilizing the ratio of the organic acid to the fluoride-continuing solutions used by Applicants, as per Gigante, since Grant himself provides a motivation to do so, because the ratio is well-known in the art as evidence by Gigante's disclosure, and furthermore, because the volumetric ratio is a result-effective variable, and its variation would have been expected from and obvious to one skilled in the art with the purpose of establishing the optimum process conditions." (Paper No. 21, page 3). As stated, Grant discloses a vapor phase process and it appears to applicants that the only teachings of such limitations appears in applicants' own disclosure, the use of which by the Examiner would constitute impermissible hindsight. This is particularly true since Grant dwells on the use of vapors and mixtures of vapors, which mixtures would be extremely difficult to control to arrive

at different ratios of constituents. Additionally, Lin's disclosure of HE solution is used in combination with an etch stop layer and thus lacks any disclosure of the preferential etching of the presently claimed invention.

Further, M.P.E.P. § 2144.05 states that a 'prima facie case of obviousness may ... be rebutted by showing that the art . . . teaches away from the claimed invention." Applicant submits that Grant teaches away from the proposed modification to the vapor process. As discussed above, Grant discloses a vapor phase treatment method to etch oxides. (Grant, col. 3, lines 35-37). The method etches oxides with a halide-containing species and a low molecular weight organic molecule having a high vapor pressure at standard conditions. Etching is performed at preset wafer temperature in an enclosed chamber at a pressure such that all species present in the chamber, including water, are in the gas phase and condensation of species present on the etched surface is controlled. Thus all species involved remain in the gas phase even if trace water vapor appears in the process chamber. (Grant, Abstract).

Grant teaches away from the proposed modification of replacing the vapor etch process in Grant with either the multi-solution-based wet etch process as used with Gigante, the alternative etch solution of Lin or the etchant solution of the presently claimed invention. Grant is directed toward a method of etching oxides on a substrate which minimizes or prevents deposition of contaminants on the substrate and specifically teaches that

> the etching of oxides is typically carried out using a halide-containing water solution, for instance a HF/water solution, or reactive ion etching (RIE). The former method is not compatible with integrated processing of integrated circuits while the latter damages the surface of the substrate and contaminates the nearsurface region of the substrate. As a result, neither method permits integration of oxide etching with other steps performed in a cluster process.

(Grant, col. 1, lines 10-19). Applicants respectfully submit that Grant teaches away from incorporating a wet etchant solution. Accordingly, applicants submit that no motivation exists with the references themselves to combine the references. Further, applicants submit that the proposed combination of references fail to teach or suggest every element of independent claim 1. Accordingly, independent claim 1 is not rendered obvious by Grant in combination with Gigante.

Claims 2 through 8 are each allowable as depending, either directly or indirectly, from allowable claim l.

Claim 8 is further allowable as the proposed combination of references fail to teach or suggest an etchant solution exhibiting a selectivity ratio of borophosphosilicate glass to tetraethyl orthosilicate between about 27:1 and 55:1. Instead, the references lack any disclosure of a borophosphosilicate glass to tetraethyl orthosilicate selectivity ratio.

Claim 9 of the presently claimed invention avoid the cited references for substantially the same reasons as claim 1. Claim 9 recites an etchant solution which selectively etches borophosphosilicate glass over tetraethyl orthosilicate, said etchant solution comprising an organic acid and a fluoride-containing solution, wherein the etchant solution exhibits a selectivity ratio of borophosphosilicate glass to tetraethyl orthosilicate between about 27:1 and 55:1. As stated, Grant does not disclose an etchant **solution** and both Grant, Gigante and Lin lack any disclosure regarding whether the disclosed vapors or etchant solutions selectively etches borophosphosilicate glass over tetraethyl orthosilicate. Further, the disclosed references fail to teach or suggest an etchant solution exhibiting a selectivity ratio of borophosphosilicate glass to tetraethyl orthosilicate between about 27:1 and 55:1. As the proposed combination of references fail to teach or suggest every element of independent claim 9, applicants respectfully submit that claim 9 is not rendered obvious by the proposed combination of references.

Claims 10 through 15 are each allowable as depending from allowable claim 9.

CONCLUSION

Claims 1 through 4 and 6 through 15 are believed to be in condition for allowance, and an early notice thereof is respectfully solicited. Should the Examiner determine that additional issues remain which might be resolved by a telephone conference, he is respectfully invited to contact Applicants' undersigned attorney.

Respectfully submitted,

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